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# Charcot Foot Ulceration

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CHARCOT FOOT ULCERATION

by

KATELIN SIEVERT

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine


University of North Dakota


in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota  
May, 2012

This Scholarly Project, submitted by Katelin Sievert in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

  
(Graduate School Advisor)

  
(Chairperson, Physical Therapy)

## PERMISSION

**Title** Charcot Foot Ulceration

**Department** Physical Therapy

**Degree** Doctor of Physical Therapy

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## ABSTRACT

This case report follows the treatment of a 64 year old male with a Charcot foot ulceration of the right foot. The study was conducted to assess the outcome of wound care to the stage three pressure ulcer and the use of a Total Contact Cast (TCC) in the treatment of the Charcot foot ulceration, as well as to present more awareness to the medical field on Charcot foot pathology and diagnosis. The study was conducted over a 16 week time period. After 15 sessions with the patient, the results showed that wound care, the use of a TCC, and custom shoes and orthotics were beneficial in treating and healing the Charcot foot ulceration.

## CHAPTER 1

### BACKGROUND AND PURPOSE

Over the last decade, the number of people diagnosed with Charcot neuropathies has significantly increased. This is probably due to the fact that the occurrence of diabetic neuropathy has increased. However, the actual incidence of Charcot neuropathy is predicted to be higher since many cases go undiagnosed.<sup>1</sup> The lack of knowledge on the pathophysiology, and clear clinical and radiologic diagnostic criteria, has made it difficult to correctly diagnose cases of Charcot foot.<sup>2</sup>

Charcot neuropathy is a progressive and disabling deterioration of weight-bearing joints, in which the ankle and foot are usually affected. The most commonly affected area of the foot is the tarsometatarsal or Lisfranc joint.<sup>2</sup> The pathophysiology of Charcot neuropathy is not well comprehended, but it is assumed to be due to multiple factors. First, the loss of protective pain sensation and proprioception allows for repetitive micro- and macrotrauma producing joint and periarticular soft tissue damage. Continued weight bearing on the joint and further tissue damage then leads to gross deformities. Second, the abnormal vasomotor regulation, which results from autonomic denervation, can contribute to a pathological change. Third, neuroarthropathic patients have increased lower limb blood flow and arteriovenous shunting. This is most likely associated with increased osteoclastic activity and bone resorption. Finally, impairment of the innervations of the intrinsic muscles of the foot may alter the loading characteristics of the foot. The impaired intrinsic muscles can cause increased heel and plantar forces which can produce eccentric loading of the foot, generating micro-fractures and ligament

laxity, which encourages joint instability and bony destruction. Together, these factors have a role in the Charcot process.<sup>1, 3</sup>

People with diabetes who have mild to severe neuropathies are most often affected, with diabetes being considered to be the most common cause worldwide.<sup>1,2</sup> In 2002, the Charcot foot was assumed to affect approximately 0.2 percent of the diabetic population. Charcot foot occurs even more exclusively in those with diabetes who are in their fourth or fifth decade of life, and who have had diabetes for 10 years or more.<sup>4</sup> This complication, which can develop very quickly, can lead to disruption of the bony foot architecture, deformed “rocker-bottom” foot, recurrent foot ulceration, and eventually, amputation.<sup>1,2</sup> Out of all individuals with diabetes, approximately 15% of them will develop a foot ulcer within their lifetime, and 84% of the time the ulcers precede a lower extremity amputation.<sup>5</sup> As a result, patients with diabetes account for approximately one-half of non-traumatic lower extremity amputations in the U.S. every year.<sup>6</sup>

Clinical diagnosis of the Charcot foot is difficult to make and often leads to a misdiagnosis such as gout, osteoarthritis/arthritis, fracture, or cellulitis. The average delay from initial symptoms to making the correct diagnosis is around 29 weeks. This is partially due to physician misdiagnoses given that the condition is not widely recognized outside of specialist clinics, and that the clinical diagnosis during the acute stage of Charcot neuropathy is not easy to make. Another key factor in the delay of a correct diagnosis is the patients underrating the symptoms of a swollen and red, but often painless foot. Therefore, more often than not, the acute phase goes completely unnoticed.<sup>1,2</sup> The clinical presentation of Charcot neuropathy is commonly seen as erythema, edema, and an increased temperature of the foot compared to the contralateral side, along with normal appearing radiographs.<sup>2,3</sup> Radiologic measures often have a hard time distinguishing acute Charcot foot from other diseases as well. X-ray radiography often

is unable to show any signs of a fracture or dislocation. Only magnetic resonance imaging (MRI) has been able to reveal, in detail, the inflammation within the bone, the nature of the bony damage, and the condition of the surrounding soft tissue. The MRI is especially useful in the acute stage of the Charcot foot.<sup>1,2</sup> A variety of laboratory tests are also typically performed, including an erythrocyte sedimentation rate and white blood cell count. However, they tend to have low sensitivity and do not help distinguish if there is infection along with the Charcot changes.<sup>3</sup>

Due to devastating results of Charcot neuropathies, and the increase in prevalence, it is becoming even more important for clinicians and other health care workers to be aware of this diagnosis. Early recognition and intervention for this syndrome can help minimize deformity and ultimately amputation. Another imperative reason for physicians and health care workers to be aware of this diagnosis is that the mortality in patients presenting with either an acute Charcot foot and/or an uninfected neuropathic ulcer is unexpectedly high. In a study<sup>7</sup> done in the United Kingdom (U.K.), the median survival for patients, with a mean age of 58 years, presenting with an acute Charcot foot to a single U.K. center between 2000 and 2007 was reduced from approximately 22 to 8 years. The poor survival of patients with an acute Charcot foot may be largely attributable to the distal symmetrical neuropathy with which the Charcot condition is universally associated.<sup>7</sup> Physicians should always consider the possibility of Charcot foot when examining a patient who is diabetic and presents with a swollen foot. Charcot process should especially be considered with the absence of fever, elevated C-reactive protein or erythrocyte sedimentation rate, which indicates that an infection is highly unlikely.<sup>1</sup> The goal of intervention should be to stop the inflammation and disrupt the destruction process that is occurring in the foot, as well as to maintain adequate alignment and architecture of the foot and



ankle in order to prevent deformity.<sup>1,2</sup> Currently, total non-weight bearing is considered crucial to the successful treatment of the Charcot foot in the initial stages.<sup>1,3</sup> Even brief periods of weight bearing can delay or prevent healing.<sup>6</sup> Total non-weight bearing is commonly achieved with below the knee total contact casts (TCC); this is considered to be the gold standard intervention.<sup>1,3</sup> When the acute stage has diminished, assisted or partial weight bearing can be gradually introduced. During this portion of the intervention, not only does the amount of weight need to be limited but also the patients amount of participation in exercise. Other interventions include: pressure relieving devices such as shoes, orthotics, removable total contact cast (RCC), prefabricated pneumatic walking brace (PPWB), and shoe-model casts.<sup>3,8,9</sup> Surgical intervention may be required for patients with marked instability, severe deformity and recurrent ulcerations. Currently, the most common operative procedure is the removal of the osseous prominence of the Charcot foot that is located on the medial or plantar aspect of the foot.<sup>1</sup> Intervention should also focus on prevention of Charcot deformity of the patient's contralateral foot, since about 25 percent of patients ultimately do develop similar changes on their contralateral foot within a couple years.<sup>3,4</sup>

The purpose of this case study is to educate people on the pathology, diagnosis and possible interventions of the Charcot foot in an attempt to reduce the prevalence of undiagnosed and misdiagnosed cases.

## Chapter 2

### CASE DESCRIPTION

The patient is a 64 year old white male. He is a retired Vietnam Veteran. The patient lives with his wife. Patient's past medical history and current problems are listed in Table 1 and includes:

Table 1: Patient's past medical history and current problems

Hypertension Nos (nitric oxide synthase)	Diabetic Neuropathies
Hyperlipidemia, mixed	Diabetic Foot Ulcer
Arthropathy, Neurogenic	Diabetes Mellitus Type II
Renal Failure	Pes Planus

Height and weight measurements of the patient are 72in and 214.6 lbs respectively. He has a BMI of 29.17, which is considered overweight. The patient is allergic to Penicillin.

Currently the patient's active medications include:

Table 2: Patient's active medication list

<b>Medication</b>	<b>Indication</b>
Amlodipine Besylate – 5mg tablet	Treatment of hypertension
Cholecalciferol (vitamin 3D) – 1000 unit tablet	Vitamin D3
Simvastatin – 80mg tablet	Help control cholesterol
Lisinopril – 40mg tablet	Treatment of high blood pressure
Insulin, Aspart, Human 100 Unit/MI Inj	Treatment of diabetes
Insulin, Glargine, Human 100 Unit/MI Inj	Treatment of diabetes

The patient was referred to Physical Therapy (PT) by a M.D. for a diagnosis of a diabetic foot wound. The PT diagnosis, stage 3 pressure ulcer to the right foot at the Charcot joint, did support that of the M.D diagnosis of a diabetic foot wound. A pressure ulcer is stated to be “a localized injury to the skin and /or underlying tissue, usually over a bony prominence, as a result of pressure, or pressure in combination with shear and/or friction.”<sup>10</sup> More specifically, stage 3 pressure ulcers are defined as: full-thickness skin loss involving damage or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia; the ulcer presents clinically as a deep crater with or without undermining of adjacent tissue.<sup>11</sup>

The wound was assessed for infection, size, drainage, and odor. Wound base was 90% pink and 10% yellow. There were signs of infection including: increased drainage, edema, and inflammation. Drainage from the wound was Serosanguinous and purulent, therefore containing serum, blood and pus.<sup>12</sup> The wounds periwound, skin surrounding the wounds perimeter,<sup>12</sup> was intact. The wound size was measured with a Dermagraft one-time use ruler. The wound measurements were determined to be 17 mm height x 15 mm width x 5 mm depth. The wound also had a tunnel that measured 12 mm in length. A picture was taken of the wound for documentation purposes and the wound was also sharp debrided with a scalpel and forceps.

Due to the wound having signs of infection, and the patient presented with acute inflammation of the foot, redness and increased temperature compared to the contralateral foot, a culture of the wound was taken. The patient did not have a TCC applied at the initial evaluation as a precaution in case of a possible infection.

An MRI was also ordered by the M.D. for the right foot to rule out the possibility of osteomyelitis due to the depth of the wound. Findings of the MRI demonstrated collapse of the midfoot and deformity and fragmentation of the cuneiforms, navicular, and anterior process of the talus. The cuboid bone of the foot was also found to be markedly deformed. A small amount of fluid was also noted to be collecting superficially to the plantar fascia. Bone marrow changes were noted throughout the adjacent bones; therefore, it was not possible to definitely exclude the possibility of osteomyelitis based on this patients MRI.

The patient had been to PT previously for the same diagnosis. The patient had Charcot foot deformity bilaterally. He had two previous ulcers on his right foot at the Charcot joint; the first ulcer was treated 4 years ago, the second ulcer was treated 3 years ago. Previous treatments

for this diagnosis included: Total Contact Cast (TCC), wound care, custom shoes and orthotics, and slow progression to full weight bearing after the wound healed. The patient had been wearing custom shoes since 2001 due to his left foot being diagnosed with Charcot foot. The patient was also educated on nutrition and given information about diabetes and a nutritional diet to take home with him.

Goals for PT were to reduce abnormal pressure on the right foot at the Charcot joint and to resolve the wound. Patient's treatment focused on wound care and pressure reduction with a TCC, and long term focus on prevention of another ulcer.

A TCC was chosen as the intervention for treating this patient's ulcer due to a number of different study results. Once the wound was healed, protective foot gear and custom orthotics would need to be re-evaluated and adjusted if necessary.

The patient was a candidate for care and the selected interventions by PT based off of clinical decision making guidelines. First, since the patient was a veteran, he was eligible for care at the clinical site. Second, the patient needed care for his wound, and PT was knowledgeable and had proper resources and equipment available to treat the patients wound.

## Chapter 3

### INTERVENTION

The main interventions for the patient in this case included: wound care treatment and immobilization with the use of a TCC to prevent bearing weight on the affected limb. Wound care treatment consisted of sharp debridement of the wound area with a scalpel and forceps. The wound was first cleaned with a 4x4 piece of gauze sprayed with CarraKlenz wound cleaner. Skin-Prep was then applied around the edges of the wound as a protective film to help prepare the skin for the attachment of the adhesive dressings to be used and prevent maceration. Collagen flakes and Silver Powder Arglaes were then applied to the wound bed to help further the wound healing and to help manage exudates and infection respectively. Then, Mepilex Ag, an antimicrobial soft silicone foam dressing, was placed over the wound bed and held in place with Medifix tape. After the wound care was completed; the TCC was applied.

The TCC should be applied with the goals of exact conformity to the lower extremity and to create evenly distributed pressure across the plantar surface of the foot. The application of the TCC is as follows: the patient has a tubular post-op stocking placed over their leg, and then low-density foam applied over the malleoli, tibial crest, and metatarsal heads. A plastic shell and outer fiberglass shell make up the cast. The cast needs to be changed every week, to allow for wound care treatment to be performed.<sup>3</sup>

Due to the patient having previous Charcot foot ulcerations, patient education on the Charcot foot disease was not needed. The patient was re-educated however on limiting his

amount of activity. Once the patient was no longer required to wear the TCC, he was re-educated on partial weight bearing and crutch walking.

Interventions by date for the patient are listed in table 3 on the next page and were as follows:

	1 <sup>st</sup> Session	2 <sup>nd</sup> Session	3 <sup>rd</sup> Session	4 <sup>th</sup> Session	5 <sup>th</sup> Session	6 <sup>th</sup> Session	7 <sup>th</sup> Session	8 <sup>th</sup> Session	9 <sup>th</sup> Session	10 <sup>th</sup> Session	11 <sup>th</sup> Session
PT Evaluation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
Active Wound Care 20cm or <: sharp debridement	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Wound Measurement	1.6cm W x 1.7cm H x .5cm D; deepest tunnel 1.2cm. Fig. 1	1.8cm W x 2.3cm H x .5cm D; deepest tunnel 1.2cm. Fig. 2	1.5cm W x 2.3cm H. Depth of wound decreased. Fig. 3	1.7cm W x 2cm H. Wound filled significantly Fig. 4	1.8cm W x 1.9cm H. Fig. 5	1.2cm W x 1.5cm H x .2cm D. Fig. 6	1cm W x 1cm H x .1-.2cm D. Fig. 7	1cm W x .9cm H Fig. 8	.3-.4cm circle x .1cm D. Fig. 9	Thin epithelial layer over wound site. Fig. 12	Full epithelialization over wound site. Fig. 13
Culture	Due to suspicion of infection										
TCC Application		Due to 1 <sup>st</sup> session culture results being (-) for infection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Order Placed to Prosthetist							Redo tread on Left custom shoe				
Prosthetist Examination								Custom shoes examined. New liner, treads & cutout area on insert to be redone & adjusted			
Patient Re-Evaluation									LE ROM, Lachman's, Sensation, and wound area. See Fig. 10, Fig. 11		
Gait/Stair Training with Axillary Crutches											<input checked="" type="checkbox"/>
Patient Education											50% weight bearing on the right foot

Table 3: Interventions per physical therapy session



The patient was scheduled to be seen via Telehealth the next week at his hometown clinic for an update on his wound area. Unfortunately, the patient had to be seen again in the clinic due to skin break down. The wound measured to be .5cm round with .2cm depth. The patient was re-casted with a TCC. The patient's wound had full epithelialization after the first week of wearing the cast, however a decision was made to keep the cast on for a month to make sure that the skin had an adequate amount of time to heal properly and to decrease the chance of future skin breakdowns. Interventions by date for the patient when he returned to physical therapy are listed in table 4 and were as followed:

Table 4: Interventions per physical therapy session

	12 <sup>th</sup> Session	13 <sup>th</sup> Session	14 <sup>th</sup> Session	15 <sup>th</sup> Session
Active Wound Care 20cm or <: sharp debridement	✓	✓	✓	✓
Wound Measurement	½ cm round, .2cm depth	Thin epithelial layer over wound site	Full epithelialization over wound site	Full epithelialization over wound site
TCC Application	✓	✓	✓	
Discharge				✓

The patient's skin had not broken down since the last treatment session, which was over 5 months ago.

Debridement is vital in healing diabetic ulcers. It includes removing all surrounding calluses, necrotic and infected tissue. Debridement is important for healing because it causes activation of platelets and growth factors that initiate the healing process. The use of topical silver applications, such as the Silver Powder Arglaes which was used with this patient, are commonly used due to the silver cation which has been shown to effectively kill antibiotic-

resistant strains of bacteria. Tissue should be kept moist after debridement to prevent deepening of the wound and facilitate cell growth. Dressings should be determined based upon the patients wound location, depth, amount of slough or exudates present, the presence of infection, condition of the wound margins, need for adhesiveness, and conformability of the dressing being used.<sup>12</sup>

Studies<sup>2, 3, 8, 9, 12, 13</sup> have stated that immobilization, to prevent weight bearing and to create effective off-loading of the affected limb, is a key element in treating diabetic foot ulcers, and have identified the TCC as the gold standard of treatment. Due to the minimal padding and careful conformity of the cast to the shape of the affected foot, TCC redistributes the weight away from the ulcer site, while still allowing patients to walk.<sup>6, 13</sup> TCCs have been shown to reduce pressure over the plantar aspect of the foot, at the site of the ulceration, by 84-92%.<sup>13</sup> Since TCC needs careful conformity to the affected foot, application of a TCC does require specially trained personnel. If the TCC is applied inappropriately, there is a risk of the ulcer worsening.<sup>12</sup> When compared to conventional dressings, TCCs were found to be effective in treating ulcers and were associated with an increased number of ulcers healing.<sup>8</sup> One study<sup>9</sup> concluded that the TCC heals ulcers in a relatively short amount of time, median of 33 days, and has healing rates of approximately 76%. Patients in that study remained in the TCC until they had intact skin over the wound area. Once healing was complete, the challenge was to keep the fragile new tissue overlying the healed ulcer from breaking open again since the new tissue was very vulnerable in the period immediately after casting. As a result, one article recommended that a TCC be used for two additional weeks after healing.<sup>6</sup> Another study<sup>5</sup> recommended that the TCC be worn for a minimum of 8-12 weeks, followed by gradual assisted weight bearing and limited exercise. Once the wound was healed, protective foot gear and custom orthotics need to

be ordered for the patient if they do not own some already, or possibly altered if the patient already uses custom orthotics.

TCCs are also beneficial and effective for control of lower extremity edema. This can contribute to improved conditions for wound healing in the presence of a pressure ulcer, as well as immobilization of the joints of the foot and ankle helps to relieve mechanical shear stress in the tissues. A TCC may be contraindicated in patients with a history of thromboembolism or a significant infection.<sup>6</sup>

Intervention of a TCC was selected for this patient due to study results and the patient's previous two outcomes with the use of this intervention for the same diagnosis.

Coordination with a local prosthetist was needed for the alteration of the patient's custom orthotics and shoes. During the time the patient was being treated, the prosthetist resoled both of the patient's custom shoes and adjusted his custom orthotics to fit the Charcot foot deformities. The prosthetist also lined the patient's orthotics with a silicone liner. Since it is common in neuropathic limbs for an ulceration to present in the contralateral limb within 36 months after the first limb presents with an ulcer,<sup>14</sup> care was taken to make sure both of the patient's shoes and orthotics fit properly to the patient's feet and Charcot deformity.

After the patient's wound healed, the patient was re-educated on crutch walking with 50% weight bearing. A scale was used to help show the patient what 50% weight-bearing felt like. He was also instructed on how to progress to full weight bearing in one month.

Wound care, the use of a TCC, and alterations to custom shoes and orthotics proved to be useful interventions for the treatment of this patient's Charcot foot ulceration.

## CHAPTER 4

### OUTCOMES

The patient's Charcot foot ulcer, of the right foot, has continued to remain healed since he was discharged. Data collected from measurements taken over the course of this case study include: range of motion (ROM), wound size and assessments, ligament testing, effusion, and risk for future ulcers. All results from the measurement are listed below in table 5 and table 6:

Table 5: Measurement Data of ROM, Sensation, and Special Test Re-evaluation

	<b>9<sup>th</sup> Session</b>	<b>11<sup>th</sup> Session</b>
<b>Hip Flexion</b>	110° Bilaterally	
<b>Hip Internal Rotation</b>	20° Bilaterally	
<b>Hip External Rotation</b>	40° Bilaterally	
<b>Left Knee Flexion</b>	120°	
<b>Right Knee Flexion</b>	130°	
<b>Knee Extension</b>	0° Bilaterally	
<b>Dorsiflexion of right foot with knee straight</b>		2°
<b>Dorsiflexion of right foot with knee bent</b>		10°
<b>Lachman's Test</b>	(+) on Left knee	
<b>Varus/Valgus</b>	WNL Bilaterally	
<b>Sensation</b>	Lack of sensation distal to the calf bilaterally	

WNL – within normal limits

	1 <sup>st</sup> Session	2 <sup>nd</sup> Session	3 <sup>rd</sup> Session	4 <sup>th</sup> Session	5 <sup>th</sup> Session	6 <sup>th</sup> Session	7 <sup>th</sup> Session	8 <sup>th</sup> Session	9 <sup>th</sup> Session	10 <sup>th</sup> Session	11 <sup>th</sup> Session	12 <sup>th</sup> Session	13 <sup>th</sup> Session	14 <sup>th</sup> Session	15 <sup>th</sup> Session
Height	1.7cm	2.3cm	2.3cm	2cm	1.9cm	1.5cm	1.0cm	.9cm	.3-.4cm	Wound closed with thin epithelial layer over wound	Full epithelialization. No adherence of tissue to bony overgrowth	1/2cm round	Thin epithelial layer over wound site	Full epithelialization over wound site	Full epithelialization over wound site
Width	1.6cm	1.8cm	1.5cm	1.7cm	1.8cm	1.2cm	1.0cm	1.0cm	.3-.4cm						
Depth	.5cm	.5cm				.2cm	.1-.2cm		.1cm			.2cm			
Tunnel	1.2cm	1.2cm													
Signs of infection	Yes; increased drainage, edema, and inflammation														
Wound Base	90% Pink, 10% Yellow	90% Pink, 10% Yellow		80% Pink, 20% Yellow	100% Pink	100% Pink	100% Pink	100% Pink	100% Pink						
Drainage	Serosanguinous and Purulent	Serous	Serous	Minimal Serous	Minimal Serous	Minimal Serous	Minimal Serous	Minimal Serous	Minimal Serous						
Braden Scale Score	24	24													

Table 6: Wound Assessment Measurement Data

The Braden Scale was assessed on the patient at the first session to predict the patient's pressure ulcer risk. Due to prevention and management of pressure ulcers consuming a large amount of resources in health care settings, preventative programs for at risk patients have been implemented and have shown to be effective in reducing prevalence rates. The Braden Scale is one measure used to identify patients who are at risk, which is a vital first step in pressure ulcer prevention. There are several scales for determining pressure ulcer risk, some including the Norton Scale, the Waterlow Scale, etc, but the Braden Scale is the most frequently used scale in the United States for evaluating the degree of risk for pressure ulcer development.<sup>10</sup>

The Braden Scale is a norm-reference scale, more than 11 published studies have provided supporting statistics regarding the Braden Scale as a reliable instrument of pressure ulcer risk by health professionals, and one systematic review concluded it was the best pressure ulcer risk assessment. Existing evidence has demonstrated that the Braden Score is both valid and reliable with the sensitivity ranging from 61%-100% and specificity ranging from 26%-100%. The highest score attainable on the Braden Scale is 23, which indicates the lowest risk for pressure ulcer development; the lowest possible score is 6, indicating the highest risk. Based on existing research, the cut-off point varies between a score of 15-18, based on the setting, for which patients are at a significant risk for pressure ulcer formation.<sup>10</sup>

Our patient scored a 23 on the Braden Scale, putting him at the highest risk for pressure ulcer development, which was logical due to his present wound at the time and having previous pressure ulcers.

The patient's effusion was not measured specifically, but rather just observed. The patient's wound was measured by the same PT each session, using a Dermagraft one-time use

ruler. Research<sup>15</sup> has reported the ruler method, which has been found to be reliable, is by far the most frequently used method to measure wounds because of its inexpensiveness and quickness. Measuring the wound to the greatest length and greatest width, with the width perpendicular to the length, has been found to be more valid and reliable than other ruler-based measuring methods. Digital pictures were also taken with every measurement. This noncontact method has very good interrater and intrarater reliability and eliminates the chance of wound discomfort.<sup>15</sup> The patient's ROM was measured by the same person consistently and was measured with a goniometer.

Results of specific testing and evaluations done during the re-evaluation at the 9<sup>th</sup> session are as follows: Patient has mild Valgus at the knees, and Charcot deformity of the feet bilaterally. Charcot deformity is greater on the left midfoot. Pressure areas on the right foot at the mid-foot/Charcot area, 2<sup>nd</sup> metatarsophalangeal (MTP), and navicular area. Pressure areas on the left foot were at the mid-foot/Charcot area and navicular area. Lachman's test was (+) on left knee. Varus/Valgus was within normal limits bilaterally.

The patient's wound healed and had full epithelialization for two weeks by the 11<sup>th</sup> session. However, the patient's skin broke down again after one week of not wearing a TCC. The patient was re-casted and after one week of wearing a TCC, the patient's wound had healed over. The patient was kept in a TCC for 3 weeks to allow the skin over the wound site to have more time for complete healing. The patient's wound continued to stay healed since when he was last seen, which has been over 5 months.

Even though the patient's ulcer has continued to remain healed, the presence of, specifically, diabetic foot ulcers has been shown to have profound effects on health-related

quality of life in those patients. It has been thought that foot ulcerations can lead to considerable negative effects on emotional, physical, and economic functioning for diabetic patients, and can lead to depression and less satisfaction with life<sup>16</sup>. Our patient specifically will have to tolerate a few disablements even though his wound has healed, some of which have an impact on his gait, and his social and emotional levels. The patient has an altered gait due to the altered Charcot foot formation he presents with bilaterally as well as the custom shoes that he wears. The patient's activity level, and therefore the amount of walking he can do, is limited. This limitation also affects the patient socially. He is unable to be out in the community on his feet for a long period of time, restricting his amount of time to spend with people outside his home. Also, the custom shoes that are made for patients who need them are very easily recognizable and although the patient did not state anything during the PT sessions, the appearance of the patients shoes could impact him both socially and emotionally due to the fact that many people would be able to recognize the difference in his shoes when he is out in the community and may stare or ask questions related to his shoes or condition. This would have an impact on his emotions, as well as the constant concern of his feet and whether another ulcer will form. The constant stress and consistency the patient needs to check his feet for ulcers, as well as the negativity of activity restrictions and the amount of activity he is able to do, may alter his mood.



## Chapter 5

### DISCUSSION

After 15 sessions with Physical Therapy, the patient's right Charcot foot ulceration was healed with the use of wound care and a TCC. The total amount of time needed for healing, which was defined as intact skin, was 109 days or 15.5 weeks.

One study<sup>1</sup> states total non-weight bearing, with a cast, needs to be applied for at least 8-12 weeks before assisted weightbearing can be gradually started.

Another study<sup>17</sup> states that the duration of TCC application is independent of the anatomical site which is involved and progression to protected weightbearing should be based on clinical judgment. The study also states, that patients with bilateral involvement of Charcot neuropathy require longer duration of TCC treatment.

In a study<sup>9</sup> that assessed the outcome of TCC treatment for foot ulcers in neuropathic patients with and without peripheral artery disease, the median duration of cast treatment was found to be 33 days; however, this study also stated that the anatomical location was also clearly related to the outcome. In this study, 76% of the patients were healed using TCC.

Table 6 from a randomized controlled trial<sup>13</sup>, lists a number of offloading modalities and the mean healing time in days for that intervention. TCC mean healing time was between 28-63 days depending on the anatomical location of the ulcer.

**Table 7—** Healing times in common offloading modalities

Offloading modality	Mean healing time (days)	Type of study	% healed	Type of wound	Ref.
<b>TCC</b>	<b>Forefoot ulcers: 30; rearfoot-midfoot ulcers: 63</b>	<b>Retrospective cohort*</b>	<b>90</b>	<b>Wagner 1, 2</b>	<b>18</b>
<b>TCC</b>	<b>Forefoot ulcers: 31; rearfoot-midfoot ulcers: 42</b>	<b>Retrospective cohort*</b>	—	<b>Wagner 1, 2, 3 4</b>	
<b>TCC</b>	<b>40</b>	<b>Retrospective cohort*</b>	<b>94</b>	<b>Wagner 1, 2</b>	<b>24</b>
<b>TCC</b>	<b>38</b>	<b>Retrospective cohort*</b>	<b>73</b>	<b>Wagner 1, 2, 3 3</b>	
<b>TCC</b>	<b>44</b>	<b>Retrospective cohort*</b>	<b>82</b>	<b>Wagner 1, 2</b>	<b>6</b>
<b>TCC</b>	<b>Midfoot ulcers: 28</b>	<b>Retrospective cohort*</b>	<b>100</b>	<b>Wagner 1, 2</b>	<b>23</b>
<b>TCC</b>	<b>34</b>	<b>RCT†</b>	<b>90</b>	<b>UT 1A</b>	<b>9</b>
RCW	50		65		
Half-shoe	61		58		
<b>TCC</b>	<b>42</b>	<b>RCT†</b>	<b>90</b>	<b>Wagner 1, 2</b>	<b>7</b>
Shoe-insole	65		32		
Removable cast boot	48	RCT†	35	UT 1A	16
Fiberglass cast shoe	34	Retrospective cohort	91	Wagner 1	19
Fiberglass cast	—	RCT‡	50	Wagner 1	20
Shoe			21		
Scotch cast boot	112, 181	Retrospective cohort*	80	Wagner 1, 2, 3	25
Windowed fiberglass cast	69	Prospective cohort*	81	UT 2A	21
Half-shoe	134		70	UT 1A	21
Half-shoe	70	Prospective cohort*	96	Wagner 1, 2, 3, 27 4	
Custom splint	300	Retrospective cohort*	—	—	22
Felted foam dressing	75	RCT§	—	Wagner 1, 2	26
Half-shoe	85				
<b>TCC</b>	<b>48</b>	<b>Prospective cohort†</b>	<b>92</b>	<b>Wagner 1, 2, 3 28</b>	
Padded dressing	36		93		
Healing shoe	42		81		
Walking splint	51		83		

\* Percentage healed in no specified time; †percentage healed in 12 weeks; ‡ percentage healed in 30 days; § percentage healed in 10 weeks. RCT, randomized clinical trial. UT, University of Texas.

Our patient had an ulcer that was located in the midfoot region, so according to Table 2, the median amount of time midfoot ulcers should heal is 28-63 days, which our patient greatly exceeded. The patient's co-morbidities, including his diagnosis of Charcot foot bilaterally, severity of his diabetes, and severity of his neuropathy, could have been a causation of his increased healing time. Other intrinsic factors of this patient, which could have also affected his tissue tolerance and the length of time it would need for healing, included his nutrition, age, and arteriolar pressure.<sup>10</sup>

More research is needed on finding more effective and time efficient treatments to heal Charcot foot ulcerations. More research is especially needed in comparing non-weightbearing methods as well as new interventions that are beginning to be studied as additional methods of providing non-weightbearing treatment, such as "instant TCC".<sup>18</sup>

There are many other interventions that are used to help treat plantar ulcers; however they were not used with this patient. Some of the excluded interventions include: Negative Pressure Wound Therapy (NPWT), reconstructive therapies, prefabricated pneumatic walking brace (PPWB), electrical bone stimulation, surgical treatment, and removable cast walkers (RCW).<sup>3, 12, 13, 19</sup> A newer method, off-loading with a removable cast walker, has also been used to treat plantar ulcers.<sup>18</sup>

NPWT was not used with this patient, due to the fact that it is commonly used to manage extensive and very complex wounds, which the patient in this case study did not present with, and therefore should be considered in postoperative wounds of the diabetic foot, large foot ulcers, amputation wounds, or when adequate healing is not occurring after 3-weeks.<sup>12, 19</sup> When compared to standard treatment for these more complex wounds, NPWT has shown to facilitate

more rapid healing.<sup>12</sup> NPWT uses a vacuum-assisted closure device and has many benefits including: providing a closed, moist, wound-healing environment; facilitating wound closure by drawing the wound edges inward; reducing infection rates; reducing edema; and increasing blood flow, mitosis, and granulation.<sup>12, 19</sup> Therapy with the use of NPWT is expensive, but, with the reduced healing time, it could ultimately provide savings due to decrease dressing costs and staff time. No major disadvantages have been found with the use of NPWT other than: pain, bleeding, patients having to be attached to the machine, and the cost. Caution should be used on patients with anticoagulation problems.<sup>19</sup>

Reconstructive therapies include plastic surgery. This is commonly not used unless the area of the ulcer has not decreased by more than 10% after other approaches (off-loading with TCC or NPWT) have been applied for two months.<sup>12</sup>

A PPWB, is an alternative to TCC. Plantar pressure in the midfoot and forefoot areas is decreased with the use of a PPWB. Easier surveillance of the ulcer, ease of application, and the ability to use several different types of dressings are some benefits for PPWB use. However, the use of a PPWB is not recommended for patients with severe foot deformity or who may be noncompliant and remove the brace while at home.<sup>3</sup>

Electrical bone stimulation can be used to enhance healing. Initial studies show promise of its use, however, the U.S. Food and Drug Administration has not labeled electrical bone stimulation as a treatment for Charcot foot. More studies are needed on this treatment.<sup>3</sup>

Surgical treatment may be indicated for approximately 25% to 50% of patients with Charcot arthropathy. For patients where surgery is indicated, the goals of surgery should be to restore stability and alignment, prevent deformity, and to facilitate functional ambulation.

Surgery could be indicated with an acute dislocation, recurrent ulcerations, and severe or uncontrolled deformity or instability.<sup>17</sup> Surgery for patients with a stable chronic Charcot foot or for those patients who experience recurrent or non-healing ulcers would therefore require an exostosectomy.<sup>3</sup> An exostosectomy (ostectomy) is a procedure done to excise any bony prominence that could cause an ulcer. For patients with increased plantar pressure, the completion of this surgery may result in nonappearance of subsequent ulcers in 92% of the cases.<sup>17</sup> If patients have a markedly unstable extremity, due to a subluxation, a joint stabilization procedure may be required.<sup>3</sup>

Removable cast walkers (RCWs) have been shown in some studies to provide off-loading which is equal to that of TCCs, but have failed to provide equivalent healing in clinical studies. In a randomized trial comparing RCWs and TCCs, 65% of ulcers healed in the RCW group compared to 90% of ulcers healed in the TCC group. One benefit of RCW is that clinicians and therapists, who would not be comfortable applying a TCC due to lack of knowledge or experience, can readily use a RCW.<sup>13</sup>

To try and make RCWs more effective, one study,<sup>18</sup> which was the first randomized clinically controlled trial of this type, created an irremovable TCC (iTCC) and compared the iTCC to a standard TCC. The iTCC is a RCW rendered irremovable by wrapping a single layer of fiberglass casting material around it. In this study, mean healing times for the TCC was 5 weeks and 3 weeks for the iTCC. The study suggested that iTCC may be as effective as the standard TCC in healing and may also have no more or fewer complications, as well as taking less time to apply and remove. The iTCC was also associated with a lower cost in this study. More research is needed on the iTCC however due to the study being the first of its kind and a relatively small sample size.

Limitations in this case study would include the fact that as the writer of this case study, I was not able to continue seeing this patient through the termination of his care, and that the information had to be sent to me. Also, since the patient lived over 4 hours away from where we were treating him, his access to health care was limited and we were unable to monitor him on his amount of activity and weight on his foot after the TCC was removed.

## REFLECTION

I picked this case, on a Charcot foot neuropathy, because of my interest in this disabling disease. I developed my spark of interest for this topic while on my second clinical rotation where I was introduced to Charcot foot neuropathies by my CI who worked with a number of patients who were dealing with different stages and implications from the disorder. Due to the number of people with diabetes, who are at risk for developing a Charcot foot, the severe complications and life restrictions that can result, the lack of research and knowledge on the pathology, and a lack of a proper protocol for treatment, I wanted to do some of my own research on the topic.

From completing this project, I have gained much more knowledge on the pathology of the disease. I have also learned that currently, treatment and interventions are based on each patient and can vary greatly. However, one factor that should remain the same in every case is the careful monitoring of the wound and patience to allow full healing time. I also learned that there is a great need for more research to be done on this disease, in both diagnosing and treating.

This project has been very beneficial to me, and has helped me learn a lot about a unique topic that I would not have learned about in school. It also gave me an opportunity to educate some of my professors and classmates on the topic and make them more aware of the disease.

## APPENDIX



## Appendix A

Figure 1: Wound Measurement Picture



## Appendix B

Figure 2: Wound Measurement Picture





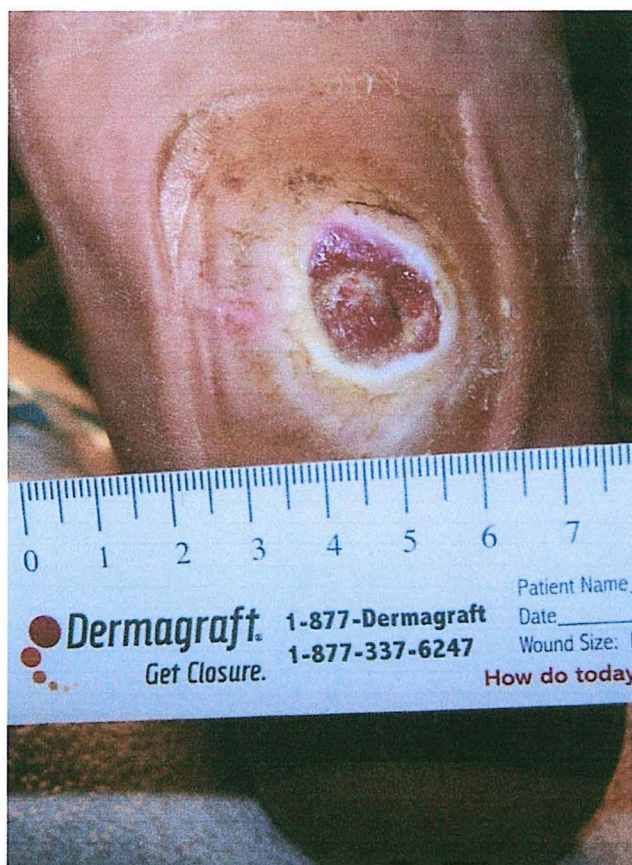
Appendix C

Figure 3: Wound Measurement Picture



## Appendix D

Figure 4: Wound Measurement Picture



## Appendix E

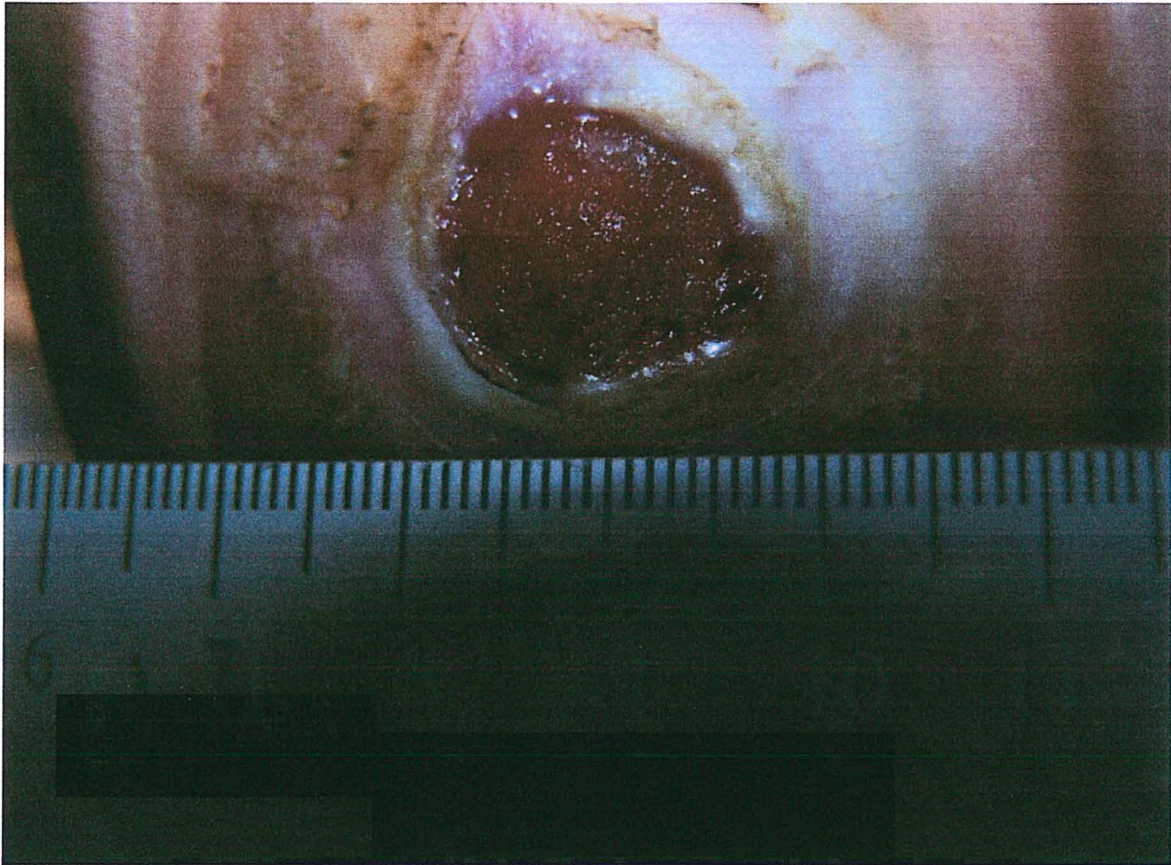
Figure 5: Wound Measurement Picture





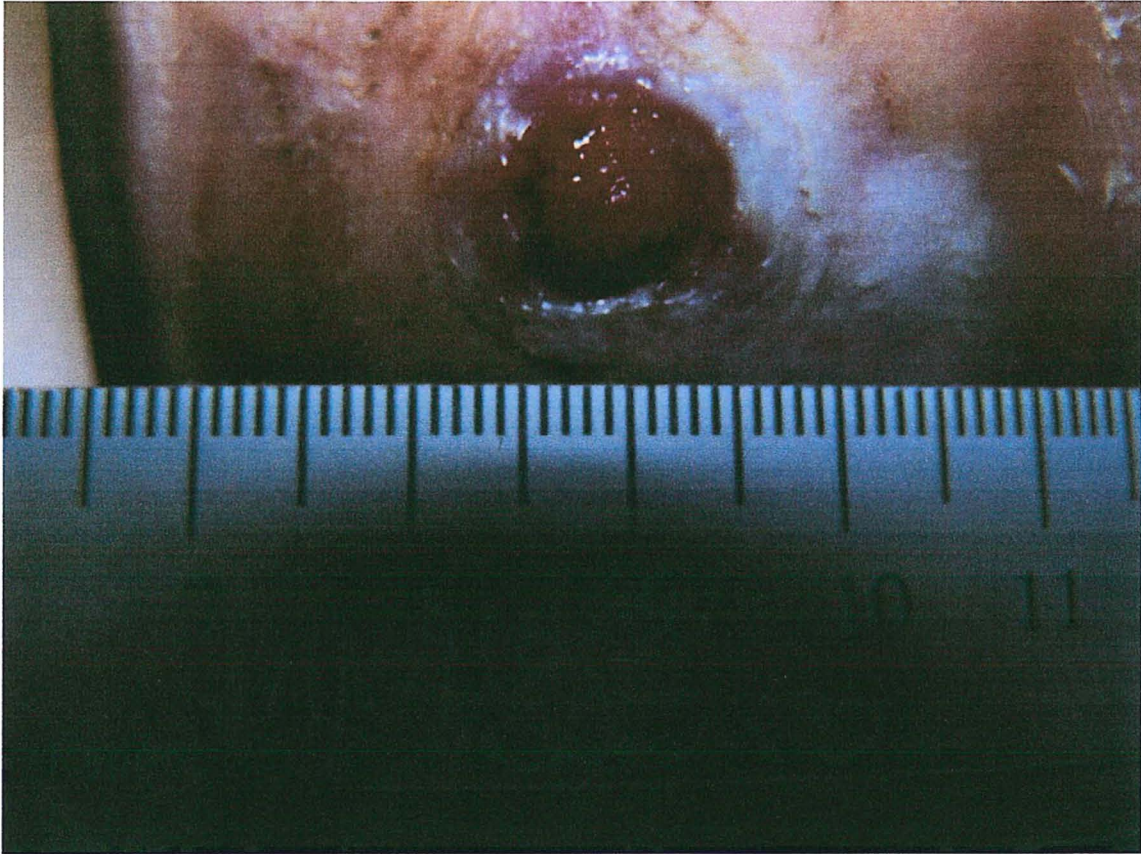
Appendix F

Figure 6: Wound Measurement Picture



Appendix G

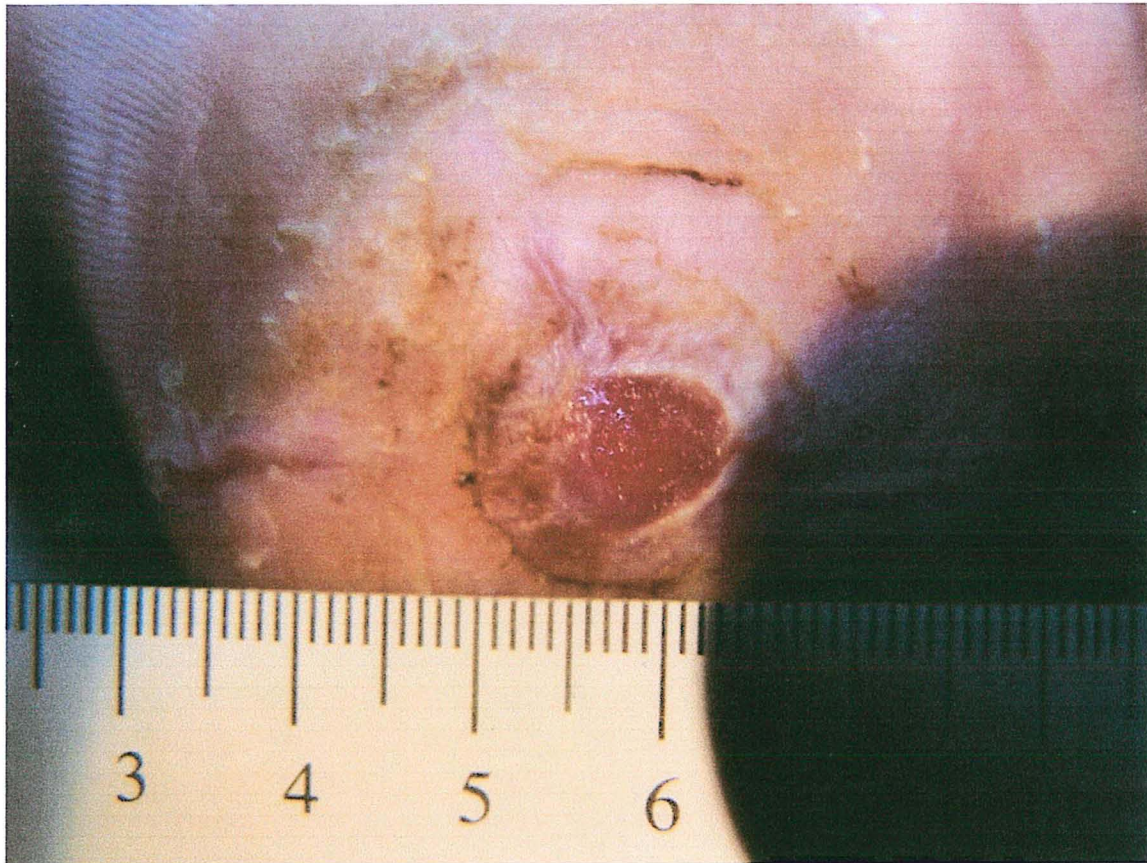
Figure 7: Wound Measurement Picture





Appendix H

Figure 8: Wound Measurement Picture





Appendix I

Figure 9: Wound Measurement Picture



## Appendix J

Figure 10: Patient Range of Motion Re-evaluation of Ankle Dorsiflexion





## Appendix K

Figure 11: Patient Range of Motion Re-evaluation of Ankle Plantarflexion



Appendix L

Figure 12: Wound Measurement Picture





Appendix M

Figure 13: Wound Measurement Picture



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